# APPENDIX

# DECLARATION OF ISABELLE BACON

I, Isabelle Bacon, do hereby declare and state as follows:

1. I have significant academic training and work experience in fields relating to materials engineering, including manufacturing methods and materials used in gas turbine rotor designs, and in particular to the unique properties of IMI 834 relative to other, more conventional gas turbine rotor materials.

2. My academic training includes:

   a. a Bachelor's Degree in Materials Engineering (1993 – Ecole Polytechnique de Montreal), which included two years of studying the forging of IMI 834; and

   b. a Master's Degree in Mechanical Engineering (1995 - Ecole Polytechnique de Montreal).

3. I am a member of Ordre des Ingénieurs du Québec (Quebec Professional Engineers' Order).

4. I have been employed continuously (except for a 1-year hiatus to complete the Master's degree, mentioned above) since 1993 as an engineer working on research and other projects relating to materials and manufacturing. My employers have included Hydro Quebec Research Center (IREQ) (1993-1995), CEZ Inc.-Noranda (1996) and Pratt and Whitney Canada Corp. (since 1997).

5. One my areas of expertise includes friction / inertia welding processes, and I have played a lead role at Pratt and Whitney Canada in researching and developing these processes, and I have been lead designer on several engine components parts incorporating these processes.

6. I am an inventor of the US application number No. 10/734,213, entitled "Compressor Rotor and Method for Making Same" (referred to below as "my invention" and "my patent application"). I have read and I am thoroughly familiar with its content including the claims.

7. I have also read and understood the French patent application No. 2,739,658 ("Broust").

8. I have also read and understood the Office Action dated April 18, 2007 ("Office Action"). There are several statements in the Office Action with which I do not agree, as I have detailed below.

9. Conventionally, gas turbine impellers are made by forging, heat treating, and then machining. Conventional possibilities for attachment of impellers to shafts include: (i) mechanically fastening the impeller to a shaft with bolts, (ii) extruding a stub shaft from the rotor for connection to the shaft, (iii) providing a keyed shaft, and (iv) providing a friction fit with a shaft. The extruded stub shaft (which is later threaded for attachment to the turbine shaft) is often preferred since mechanical fasteners add unwanted weight, keyed shafts add stress concentrations, and all designs present dynamic issues.

10. Gas turbine compressor impellers are conventionally made of alloys such as titanium Ti-6Al-4V or Ti-6-2-4-2, which are relatively easy to work, but have maximum temperature limits above which they are no longer as useful for making gas turbine impellers. For this reason, higher temperature titanium alloys have been sought by the gas turbine industry.

11. IMI 834 (also known as Ti-5.8Al, 4Sn, 3.5Zr, 0.7Nb or Timetal 834), is a relatively new, so-called "high temperature" titanium alloy which has highly desirable properties for aircraft engine components operating at higher temperatures, such as high temperature creep resistance, and high tensile and fatigue strengths. This is well-known. However, as people skilled in this material field also well understand, IMI 834 presents some very special and difficult problems for designers of gas turbine impellers, since impellers are relatively large components and IMI 834 typically leads to poor mechanical performance for components of that size. More particularly, when IMI 834 impellers are made with conventional manufacturing techniques, such as those mentioned in paragraph 9 above, these IMI 834 impellers tend to have a poor low cycle fatigue (LCF) life. For this reason, thus far IMI 834 impellers have not been able to meet industry standards for impeller life, and hence IMI 834 has not been successfully adopted in the gas turbine industry for use with impellers. Despite all of IMI 834's desirable properties, I am not aware of any commercially-available gas turbine having an IMI 834 impeller. There has been a lack of a viable manufacturing process.

12. By employing the manufacturing technique described in my patent application, it is possible to provide an IMI 834 impeller which has sufficient properties to enable a commercially-viable gas turbine impeller. By forging only a stump portion of a stub shaft, instead of extruding the entire stub shaft as would usually be done in the prior art, I have found that a sufficient amount of work is achieved to provide good mechanical properties while, at the same time, the introduction of the unacceptable internal regions of weakness introduced by extrusion is avoided. The remainder of the stub shaft may then be provided and attached by any suitable method, such as welding.

13. French patent application no. 2,739,658 ("Broust") is directed to a bimetallic turbine shaft having an integral flange, which is a completely different component, in design, function, operational environment and performance, from a compressor impeller. A person skilled in the design of compressor impellers would not consider the design of turbine shaft flanges an analogous design field, because the relative sizes/masses, shapes, functions, materials and temperatures to which the components are subjected in use are so different. In my opinion, Broust teaches nothing relevant to the manufacturing of IMI 834 gas turbine impellers.

14. Broust teaches a method of welding a bimetallic turbine shaft. Integral with the shaft is a flange with bolt holes for fastening to the turbine disc (which is analogous to one of the *prior art* impeller rotor assembly techniques described briefly above in paragraph 9). Also, the flange of Broust is not itself analogous, in size, shape or function, to the impeller of my patent application. The flange is not an aerodynamic component adapted to be driven by a fluid flow. The flange is not considered as a "critical" rotating part by airworthiness authorities such as the FAA. From the point of view of a person skilled in the manufacture of gas turbine impellers, there are no relevant similarities between the turbine shaft flange of Broust and a gas turbine impeller.

15. I respectfully disagree with the Examiner's statement that Broust teaches "...minimizing extrusion in the region" of Broust's flange (see page 3 of the Office Action). Broust is silent about extrusion, and furthermore, based on the geometry presented in Broust in my opinion it would be apparent to any person skilled in the field of forging/extrusion that the process of Broust will result in significant extrusion. The geometry and materials in use by Broust would not benefit from minimizing extrusion, because they are not sensitive to extrusion in the same way that I have found that IMI 834 is.

16. Moreover, Broust is silent about titanium alloys and, more particularly, IMI 834. Broust teaches solely how to weld two iron alloy shaft parts together to constitute a bimetallic turbine shaft.

17. I respectfully disagree with the Examiner's statement that the Background of my patent application (i.e. the so-called "AAPA") "...teaches forging and no additional or subsequent processes of the compressor part [which] suggests that no additional or subsequent processes occur (including extrusion) during or after the forging step" (see Response to Arguments section of the Office Action). As mentioned in paragraph [0002] of the patent application, conventional compressor impellers with stub shafts have included extrusion of the stub shaft. There is no suggestion in the AAPA that *conventional impeller stub shafts included forging* without extrusion.

18. In my opinion, my invention is novel and inventive over the teachings of Broust.

19. I declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by a fine or imprisonment, or both (18 U.S.C. Sec. 1001), and may jeopardize the validity of the application of any patent issuing thereon.

**AND I HAVE SIGNED ON THIS 15th DAY OF OCTOBER, 2007:**

ISABELLE BACON

Sworn to before me in the city of Longueuil,
Québec, Canada on this 15th day of
October, 2007

Commissioner of Oaths

**CERTIFICATE OF FACSIMILE TRANSMISSION**

I hereby certify that this paper is being facsimile transmitted to the United States Patent and Trademark Office on the date shown below.

Sébastien Clark, Reg. No. 56,651

Name of person signing certification

Signature

October 17, 2007

Date